Progress in IFE Technology: April - June 2000, (Cont'd.)

Target Fabrication, Injection and Tracking:

D. Goodin, A. Nobile, G. Besenbruch, R. Petzoldt, N. Siegel and W. Steckle—General Atomics and Los Alamos National Laboratory

- The preliminary piping and instrumentation diagram for the Target Injection and Tracking Experimental System was prepared.
- Design concepts and sketches for target loading and propellant gas supply and a fast acting propellant gas valve specification were prepared.
- The target sabot design was updated and a sabot latching mechanism was designed. Expected and allowed gas leakage into the sabot were calculated. Prototype sabots were built for sabot release testing and gas leakage testing.
- Direct simulation Monte Carlo modeling of thermal interactions between the target and the gas in the target chamber was initiated.

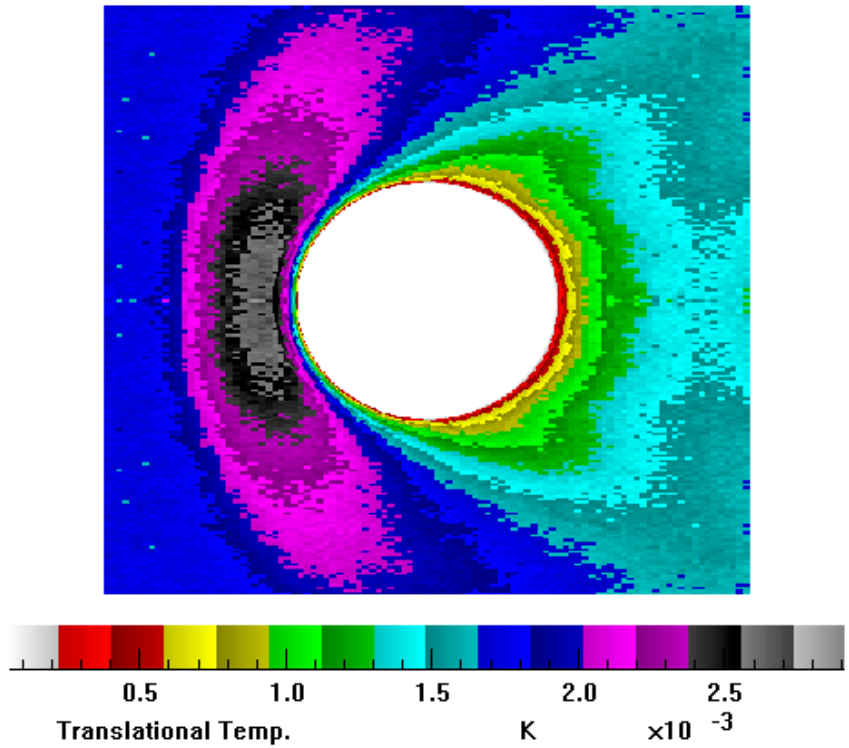


Figure 1. Image of the translational flow temperature around a target injected at 600 m/s into a chamber at a temperature of 1758 K with a 0.5 torr (standard) xenon fill. The target surface is held constant at 18 K. Notice the shock heating in the stagnation region.

Publications and Presentations:

D. T. Goodin "Developing the Basis for Target Injection and Tracking in Inertial Fusion Energy Power Plants," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.

K. R. Schultz, "Target Selection for ARIES-IFE," Presented at the ARIES-IFE kickoff meeting in Madison, Wisconsin, 19-21 June 2000.

D. T. Goodin, "Developing the Basis for Target Injection and Tracking in Inertial Fusion Energy Power Plants," Presented at the ARIES-IFE kickoff meeting in Madison, Wisconsin, 19-21 June 2000.

R. W. Petzoldt, Target Injection and Tracking System Design Description, General Atomics Doc. 7-0001-01DD, May 2000.

R. W. Petzoldt, Target Injection and Tracking System Design Requirements Basis, General Atomics Doc. 7-0001-02DR.

Progress in IFE Technology: April - June 2000, (Cont'd.)

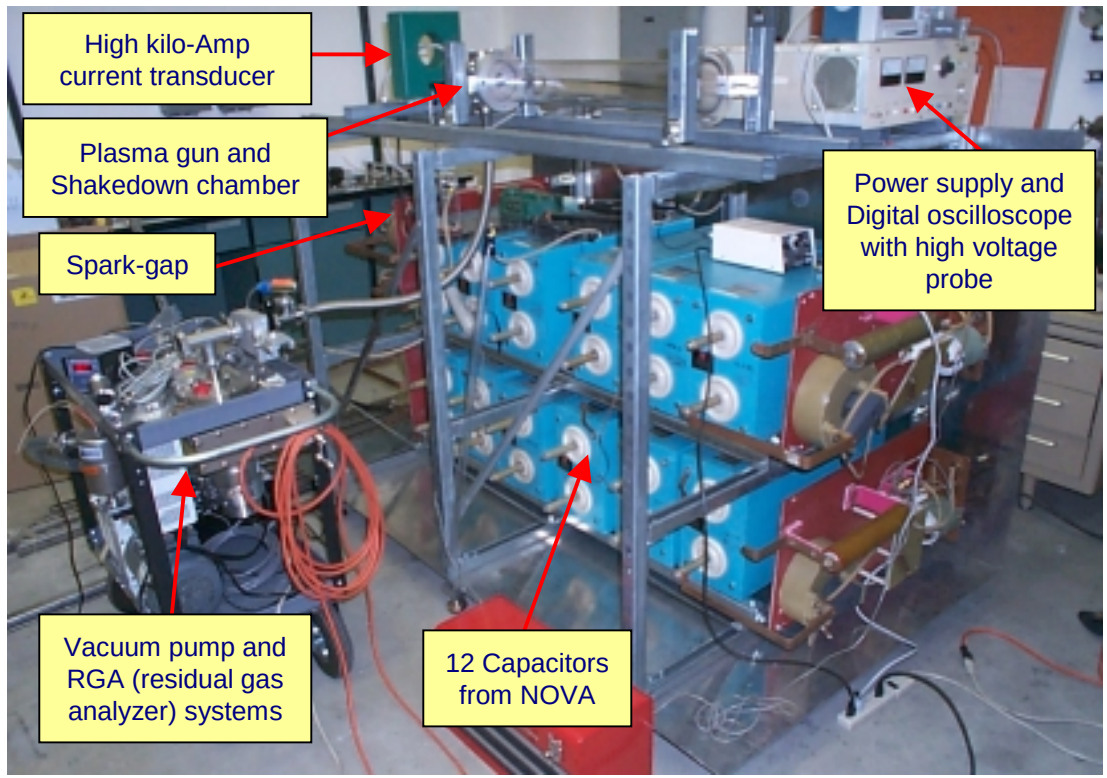
Thick-Liquid Protection:

N. B. Morley, A. Y. Ying and M. Abdou—University of California at Los Angeles (see web site at www.fusion.ucla.edu/IFE)

- Flibe Vapor Condensation Experiment:
  - Obtained first pressure measurements in the test chamber during test discharge. The discharge current measurements confirmed that the discharge pulse characteristics are adequate to simulate IFE post-shot early events
  - Built a Flibe casting device in order to make Flibe tubes as ablation liners for producing Flibe vapor cloud

- Liquid Jet Deformation Experiment:
  - Initial test performed with nozzle with rounded ends showed reduction in surface wave generation from corner regions.
  - Optimizing upstream nozzle compression profile with end curvature is difficult challenge.

- Grazing Incidence Liquid Metal Mirror Calculations:
  - Calculations using modified ABLATOR code from LLNL show a much reduced tensile pressure effect at the liquid metal free surface as compared to Moir's initial calculations.
  - Suggests that high laser energy density can be tolerated before spallation occurs.
  - Allows smaller laser incidence angles, and thus, greater tolerance to surface waves.



Publications and Presentations:

P. Calderoni, A. Y. Ying, T. Sketchley and M. Abdou, "An Experimental Facility to Investigate Vapor Condensation and the Reactor Chamber Vapor Clearing Rate for Inertial Fusion Energy Liquid," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.

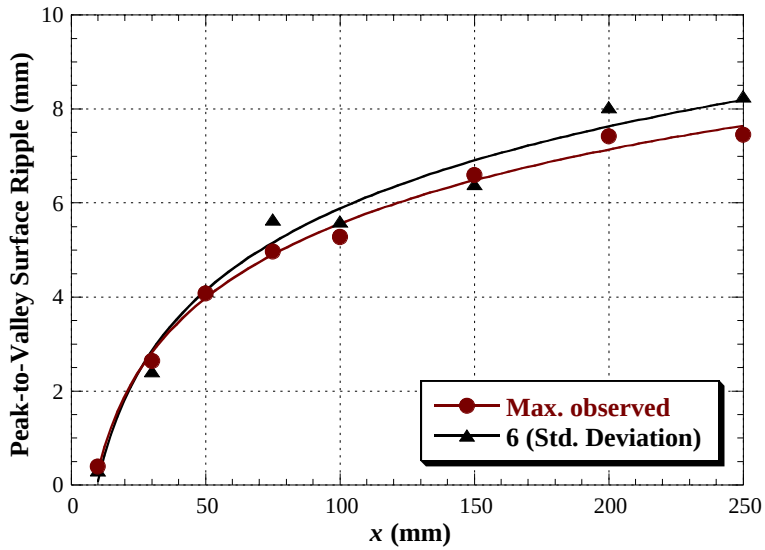
Progress in IFE Technology: April - June 2000

Thick-Liquid Protection:

J. A. Collins, D. Sadowski, M. Yoda and S. I. Abdel-Khalik—Georgia Institute of Technology

- Performed surface ripple measurements in turbulent slab jets, or liquid sheets:
  - Measurements at $Re = 3.4 \times 10^4$
  - Normalized downstream distance, $x/\delta \leq 25$
- Measurements show that surface ripple grows <u>logarithmically</u> with the downstream distance.

Can the stringent requirements upon sheet smoothness based upon a linear growth assumption be relaxed?



Turbulent jet surface ripple as a function of downstream distance

<u>Publications and Presentations:</u>

J. A. Collins, M. Yoda and S. I. Abdel-Khalik, "Direct Measurements of Free-Surface Smoothness in Turbulent Liquid Sheets," abstract submitted (manuscript in preparation), *14th American Nuclear Society Topical Meeting on the Technology of Fusion Energy, Park City, UT (2000).*

L. C. Elwell, D. L. Sadowski, M. Yoda and S. I. Abdel-Khalik, "Dynamics of oscillating turbulent liquid sheets," *Ibid.*

Safety and Environment:

D. A. Petti, B. J. Merrill and R. L. Moore—Idaho National Engineering and Environmental Laboratory

- Developed database containing thermal properties of Flibe.
- Adapted MELCOR and ATHENA safety codes for use of Flibe.

<u>Publications and Presentations:</u>

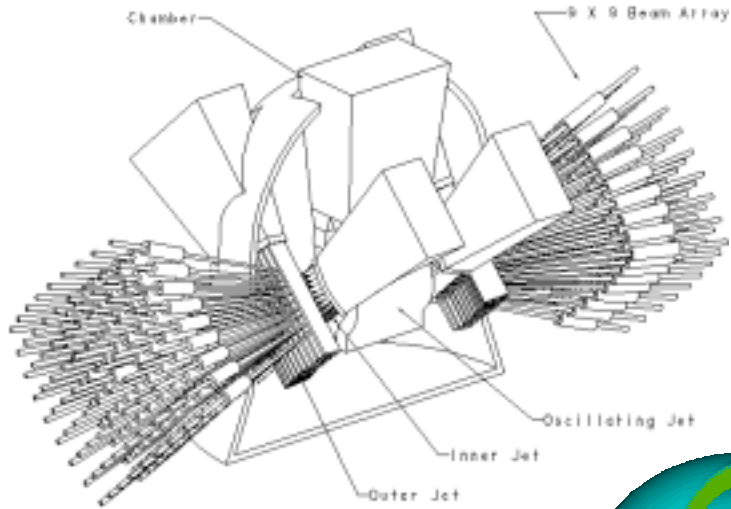
R. L. Moore, "Flibe Thermal Properties for Use with the Fusion Safety Multi-fluid Equation of State Package," INEEL/EXT-2000-00670, May 2000.

Progress in IFE Technology: April - June 2000, (Cont'd.)

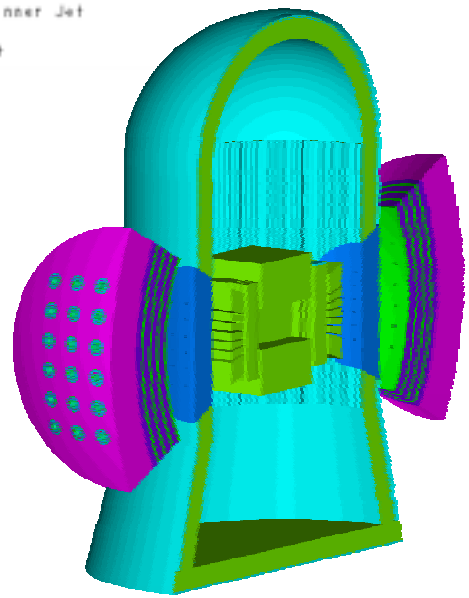
Integration, Safety & Environment, Final Focus Magnet Shielding:

W. R. Meier, J. F. Latkowski, R. W. Moir, S. Reyes, and H. K. Springer—Lawrence Livermore National Laboratory

- Participated in Goal Definition Meeting for the [Heavy Ion] Integrated Research Experiment (IRE) at LBNL. Met with LLNL Site Planning Group to discuss possible locations for the IRE at LLNL Site 300 and Site 200 (main site).
- Attended the ARIES-IFE kick-off meeting in Madison, Wisconsin. LLNL IFE Technology group will contribute to efforts in Target and Chamber Physics, Chamber Nuclear Analysis, Laser Final Optics, Heavy-Ion Final Optics, Systems Codes, and Safety and Environment.
- Improved heavy-ion final focusing magnet shielding design to extend magnet lifetime to greater than the plant lifetime.
- Preliminary results are available for a loss-of-flow/loss-of-confinement accident in the Sombrero power plant design. Collaboration with INEEL Fusion Safety Group on accident analyses is continuing and is providing mutual benefits.
- Created Pro-Engineer model of HYLIFE-II target chamber, flibe cross jets, and final focusing magnets. Model will be used to address lay-out/interface and mechanical issues.



Pro-Engineer model of HYLIFE-II chamber and final focusing system



Magnet shielding calculations are now performed using 3-D representations of the chamber, flibe pocket, and magnet arrays.

Publications and Presentations:

J. F. Latkowski, S. Reyes and W. R. Meier, "Progress in Safety and Environmental Aspects of Inertial Fusion Energy at Lawrence Livermore National Laboratory," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.

W. R. Meier, "An Integrated Research Plan for IFE Technology," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.

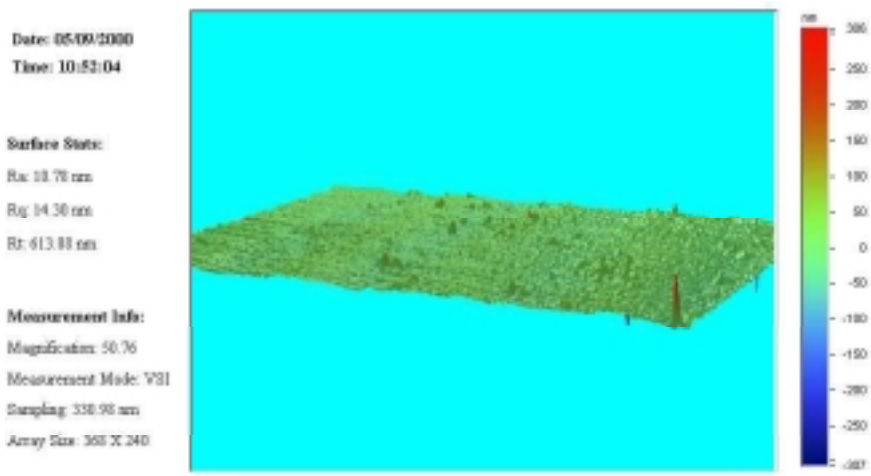
J. F. Latkowski, "Parametric Studies for Final Focus Magnet Shielding," Presented to the Final Focus Transport Group, LBNL, June 7, 2000.

Progress in IFE Technology: April - June 2000, (Cont'd.)

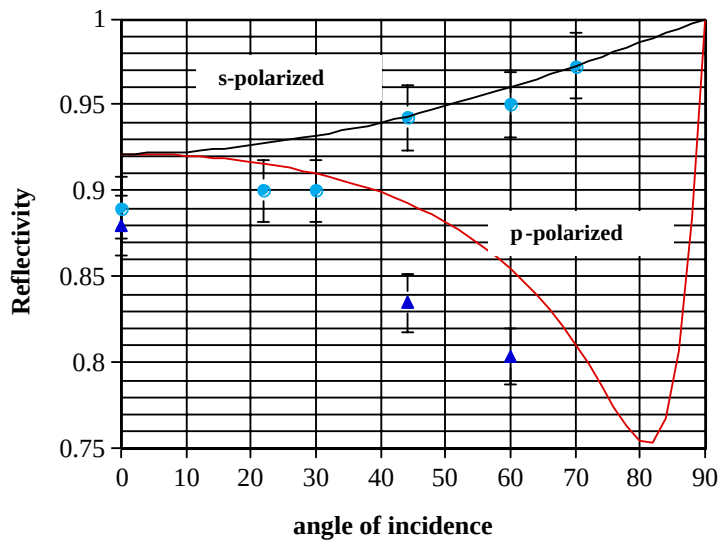
Laser Interactions and Final Optics Studies:

M. S. Tillack, F. Najmabadi, D. Blair, A. Newkirk—University of California at San Diego
J. Kaae and K. Schultz—General Atomics

- Bare, 1-inch round Al mirrors were fabricated and profiled at GA. Surface flatness and roughness are ~10 nm (λ/50).
- First measurements of reflectivity for s- and p-polarizations were obtained at 532 nm using a thermopile detector (~2% accurate).
- **Observations:** The reflectivity appears to be degraded by 3-4% at normal incidence as compared with theory. This is consistent with the reduction observed in previous experiments resulting from oxide formation. According to the literature, Al_2O_3 is fairly transmissive, and should remain thin (89% reflectivity is consistent with 200 Å of oxide). At grazing incidence the data approaches the theoretical prediction.
- Larger mirrors are desirable to obtain data at very shallow angles (85˚). Fabrication and testing of film-coated mirrors also are under consideration.
- A cavity ringdown reflectometer is being designed to provide more precise measurements of near-unity reflectivity.



Surface map of diamond-turned Al mirror



Comparison of thermopile reflectivity data with theoretical predictions for Al at 532 nm

Progress in IFE Technology: April - June 2000, (Cont'd.)

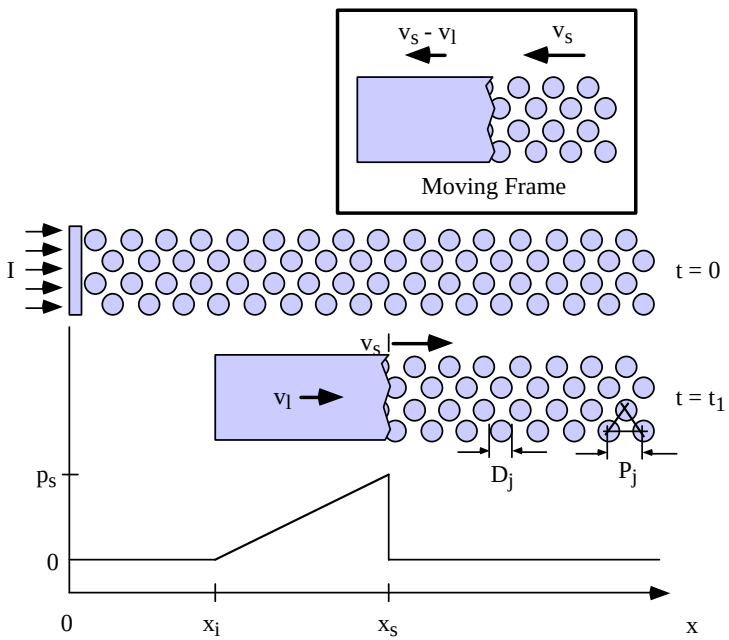
Thick-Liquid Protection:

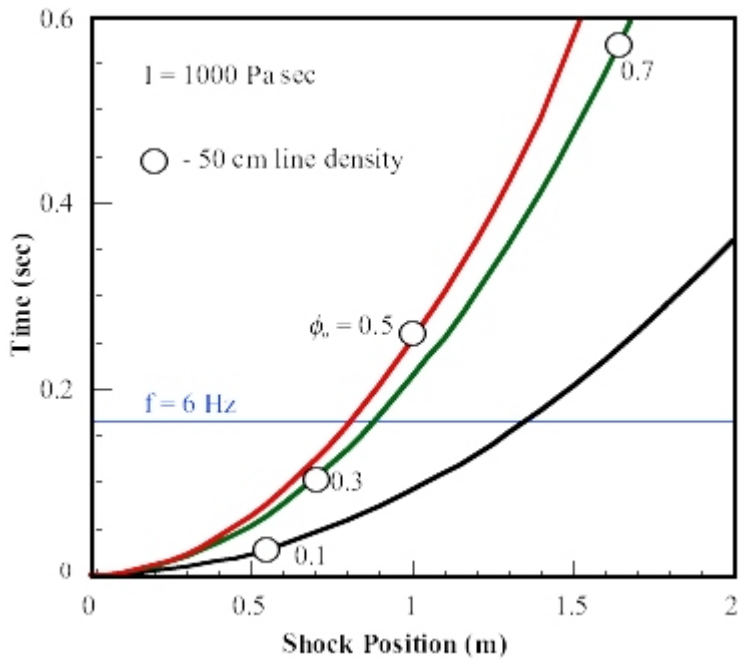
P. F. Peterson, C. Jantzen, S. Pemberton, C. Debonnel—University of California at Berkeley

- Fabrication of four-cartridge firing mechanism for burst-mode disruption of partial thick-liquid pockets is complete, high-speed solenoid-driven firing pin assemblies have been designed and are being fabricated.

- Collaboration with LBNL HIF final-transport work, and LLNL neutron shielding work, has progressed toward identifying self-consistent beam-line jet grid requirements and geometries. Particular attention has been focused on cylindrical jet arrays, where flow control to individual jets can be used to correct pointing errors.

- An analytical "snow-plow" model was developed for shock propagation in voided liquid blankets, shown below. Encouraging results show that for a substantial range of void fractions, ϕ, the shock transit time exceeds the target injection period. (The liquid will be expelled before shock break-through occurs.)





Publications and Presentations:

S.J. Pemberton, P.F. Peterson and C. Jantzen, "Scaled Study of Hydraulic Response During HYLIFE II Pocket Disruption," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.

Progress in IFE Technology: April - June 2000, (Cont'd.)

Gas Dynamics, X-Ray Ablation and ARIES-IFE:

R. R. Peterson and G. L. Kulcinski—University of Wisconsin-Madison

- Target output calculations for direct and in-direct drive targets with the 1-D BUCKY and ONEDANT codes are ongoing. Output includes time-dependent x-ray, ion and neutron spectra.

- Initial experiments were performed on Z (at Sandia) to study ion output spectra from direct-drive targets:
  - A thin plastic foil was irradiated by on the order of 1 kJ/cm^2 of z-pinch produced x-rays
  - C and H ions were collected in a plastic sample
  - The lengths of damage tracks will be measured after plastic is appropriately etched
  - These experiments will be used to benchmark BUCKY's predictions of ion spectra

- As part of ARIES, work has been performed on several aspects of the SOMBRERO dry-wall, gas-protected target chamber concept. Included are:
  - BUCKY calculations of the target chamber gas behavior
  - Thermal heating of the wall
  - Target chamber neutronics
  - Possible design modifications
  - Use of a cooled target injection tube has been considered as a means of avoiding excessive heating of the target during injection

Publications and Presentations:

G. L. Kulcinski, "Dry Wall Chamber Issues for the SOMBRERO Laser Fusion Power Plant," Presented at the IAEA Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers in Madrid, Spain. June 7-9, 2000.